Space Weather Technical Forecast

Issued on Tuesday, 06 August 2024 at 01:11 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1/R2 Expected. Chance of S1 slowly declining.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity measured at GOES16 was High, with numerous large flares from diverse sources, peaking with a long-period X1.7 from Ex-AR3767 at 05/1340UTC, closely followed by an X1.1 from AR3780 at 05/1527UTC. Both of these events were associated with Type II radio emissions of 171km/s (a possible typo?) and 925km/s respectively. A third type II emission of estimated velocity 443km/s was also observed at 05/0524UTC from an earlier M6.1 from AR3780.

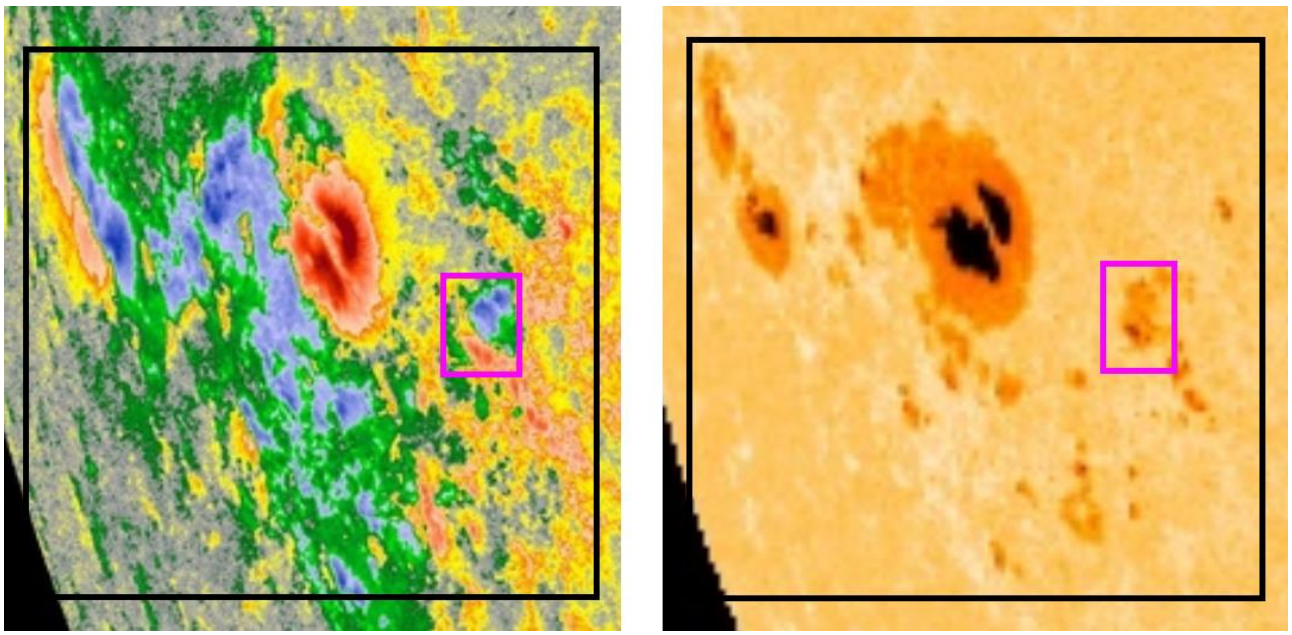

Figure 0: Sunspot region AR3780 as it appeared at 05/2330UTC. This sunspot currently spans around 24 degrees solar longitude and manifests as an Fki/BGD, with the potential Mt Wilson delta spot shown boxed in magenta. This appears to be the source for at least two of the larger recent flares from this sunspot group.

There are now up to ten sunspot regions on the visible disc, with two small unipolar regions developing as Ex-AR3767 became indistinct on the western limb. Of the surviving sunspot regions, by far the largest and nominally the most complex has been AR3780 in the southeast, with this group occupying an expansive plage area and currently spanning 24 degrees solar longitude as an Fki/BGD. The candidate for the Mt Wilson delta spot features amongst the leading spots and this has been the apparent source of a number of larger, impulsive X-ray flares in the period.

The main solar region changes otherwise observed in recent hours have been proliferation in the trailing portion of AR3774, while AR3780 showed similar development in its leaders, although some of the more eastern detail is likely hidden by the viewing angle. Meanwhile a fading trend

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was observed in the leading spots in AR3775.

There have been numerous Coronal Mass Ejections (CMEs) seen in coronagraphs in the period. All three of the type II radio bursts were associated with CMEs in coronagraphs, albeit with peripheral trajectories (to be confirmed by recently submitted MOSWOC Enlil modelling). In addition to these, a filament eruption was observed to leave the northeast disc (e.g. in Learmonth H-Alpha) at 05/0530UTC, with a second leaving the southeast at 05/0930UTC. Finally, a third possible filament eruption was perhaps observed in Big Bear H-Alpha around the time of the M1.2 flare (05/1837UTC) from AR3774 in the southeast-central disc. Imagery to ascertain as to whether any ejecta was associated with this final event is not yet available at the time of writing.

All considered, at present no Earth-directed CMEs have been identified, with the possible main exception of the southeast-central M1.2-linked event, and acknowledging modelling results have yet to become available for the X-class-linked events.

Solar Wind / Geomagnetic Activity: Much of the past 24 hours' solar wind behaviour does not have a definitively identified cause, however the residual effects of the 01 Aug CME were then perhaps followed by further weak transient arrivals and then possible minor fast wind and SSBC-linked characteristics.

The solar wind, as observed by ACE at L1 showed solar wind speeds that were initially Slightly Elevated near 400km/s, rising to become Elevated into the past UTC afternoon at 525km/s peak, abating slightly to 450km/s by the period's end. The solar wind density was erratic, but contained within typical background levels of single figures ppcc. The IMF was Elevated at an early peak of 22nT, although this was combined with a benign Bz component that was strongly co-aligned with Earth's field, giving an absolute range of between +19nT and only a brief dip to -10nT. The phi angle was mainly positive (away from the Sun), but an SSBC occurred at 05/1930UTC with a negative phi angle then rounding out the 24 hours.

The net result of the above solar wind measures was Quiet to Unsettled, peaking with a provisional Kp 3+ in the 06-09UTC interval.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 rose from resting Background levels in response to the long-period X1.7 flare from off-going AR3767 on the western solar horizon. The spectral response was hard but not high in magnitude, with 100MeV proton levels at GOES18 peaking at roughly 0.5pfu before plateauing, while 10MeV have shown a later apparent peak near 3.5pfu as of the time of this bulletin (i.e. sub S1 at 10pfu).

High energy electron flux (greater than 2MeV) observed at GOES16 was at Normal Background levels. The 24-hour fluence was below the Active threshold with 9.08e5 integrated pfu observed at 06/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High solar activity is forecast to continue, with occasional M-class flares Expected and with a Chance of isolated X-class flares.

Solar Wind /Geomagnetic Activity: No CMEs nor significant fast winds currently feature in the forecast, although imagery and modelling are awaited for some of the past 24 hours' events. More reliably Quiet geomagnetic activity is expected through the UTC midweek period, although confidence in its continuation falls off before the UTC weekend.

Energetic Particles / Solar Radiation: There is a Chance of S1 or greater events at first given the recent history of Ex-AR3767 and the currently raised proton counts in the near-Earth

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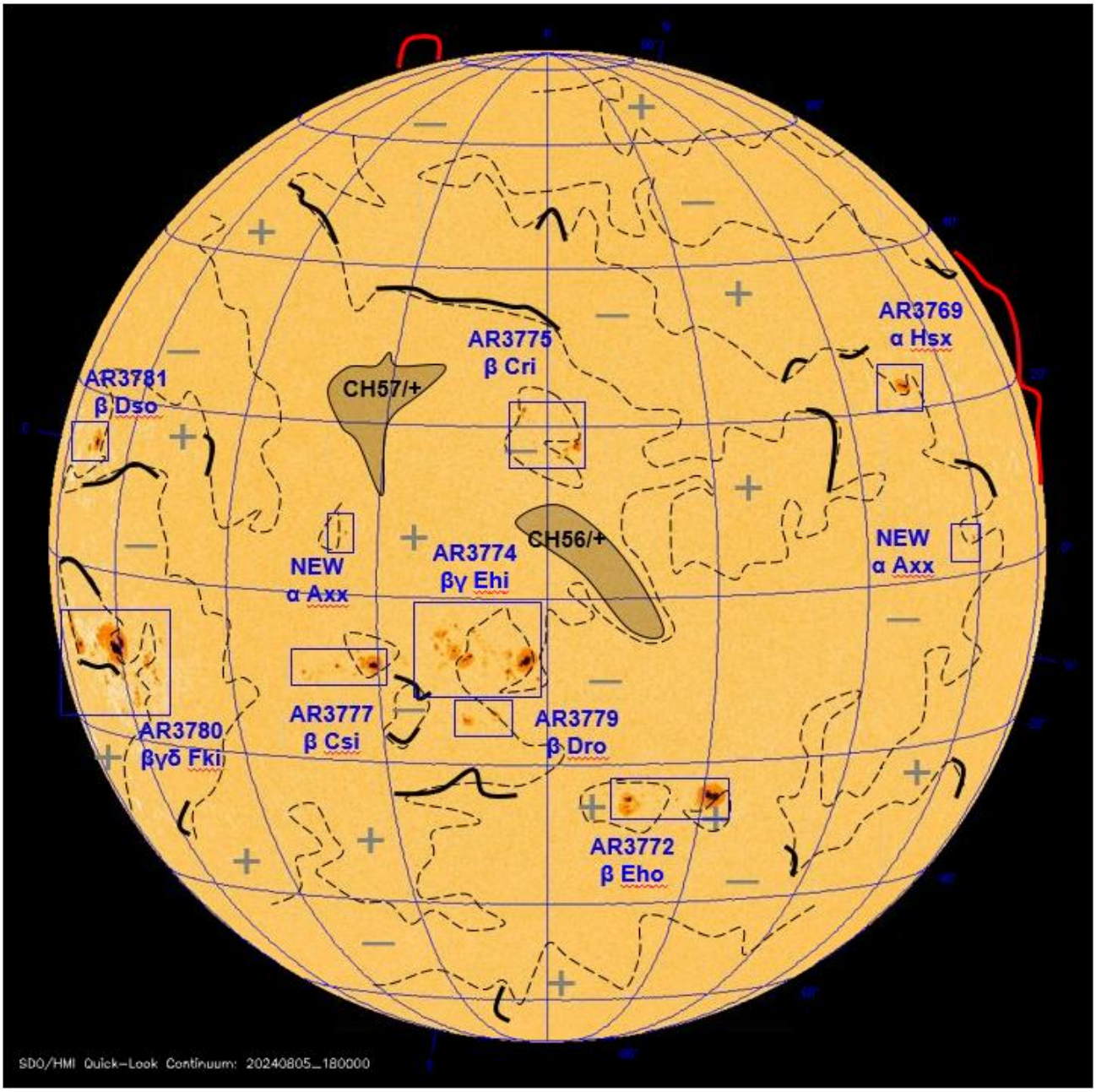
environment, however this risk should relax to a daily Slight Chance after UTC midweek.

The high energy electron flux is forecast to be at mostly Normal Background levels. The associated 24-hour fluence will probably remain below the Active threshold (1e8 integrated pfu) throughout.

Figure 1. Solar Analysis Valid 05/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No CMEs currently feature in the forecast. Modelling results are awaited for the peripheral X-class-linked CMEs, and coronagraph imagery is awaited for a possible southeast-central filament eruption from the M1.2 at 05/1837UTC near AR3774. Confidence in the transient forecast is therefore lower than is typical.

Equally, no significant fast winds feature in the forecast, with CH56/+ currently near centre-disc very tenuous on AIA211 imagery and non-persistent, but perhaps offering an increased Chance of Active intervals to end the current UTC working week.

Geomagnetic activity should therefore become more reliably Quiet for a time through the middle of the coming UTC week, however confidence in this state of affairs persisting is lower than average as we near the UTC weekend, not lest because of the complex current disc in terms of sunspots.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Currently nil, but modelling results and further imagery pending.

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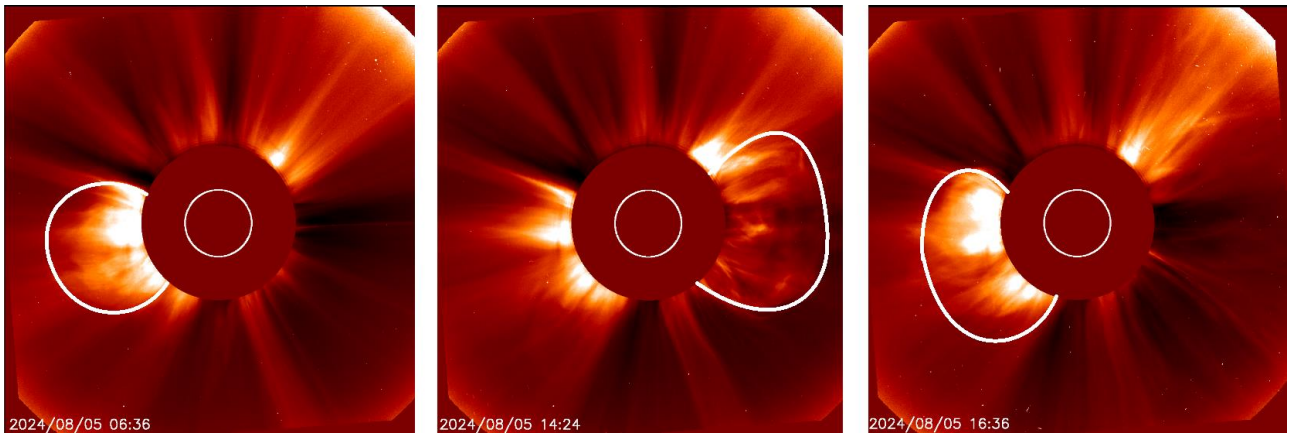
Figure 2: CMEs tied to the three largest X-ray events of the period, with all producing Type II radio bursts. Modelling results are pending for the more recent two CMEs, however any Earth impacts are expected to be small if present given their limbward emission locations.



Radio Blackouts - X-Ray Flares:

M-class flares are Expected throughout the coming four-day period, with several diverse sources on the current and recent disc having proved capable of producing R-scale events, not least AR3774 and AR3780 which should be present throughout the period. The contribution from Ex-AR3767 is now removed from the equation, which is the rationale for the slight dip in risk relative to earlier issues of this guidance.

X-class flares are rated at a Chance initially given the recent history from AR3780 and the presence of a tenuous delta spot here, perhaps relaxing slightly through UTC midweek given the groups apparent maturity and relatively slow areal changes observed in this group over the past 24 hours.

No significant regions now arrive or depart in the four days, and the risks of significant flares are unaltered after UTC midweek.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	Yes	25	20	20	20

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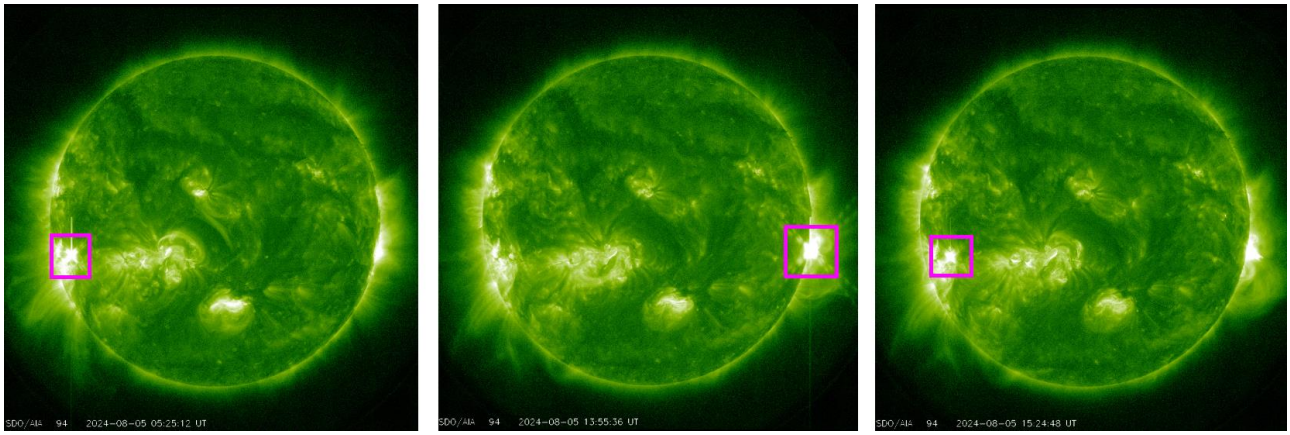
Figure 3: False-colour AIA094 imagery of the sources (boxed magenta) of the three largest X-ray flare events of the past 24 hours. The rightmost source region (Ex-AR3767) is no longer on the Earth-facing side of the Sun.



Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES18, is currently slightly above resting Background levels as a result of the X1.7 flare from Ex-AR3767. While the flux from this event appears to be plateauing, the now slightly raised proton levels in the near-Earth environment and precedent for activity from Ex-AR3767 should now give a slightly enhanced risk of S1 events in the near-term. This risk should then relax to more closely match the risk from the surviving solar disc later this UTC working week, as Ex-AR3767 rotates sufficiently far onto the far side. The bulk of the residual risk then arises from AR3780 and AR3774, which are present throughout and have proven capable of at least R2 as they advance westwards.

Radiation Storms	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ S1**	No	25	20	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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Figure 4: Past 24 hours' GOES16 X-ray flux and linked GOES18 proton flux. Note the relatively rapid response across the GOES18 proton energy spectrum to the X1.7 event from Ex-AR3767.

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High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES16, is currently at Normal Background levels, however some enhancement has likely occurred below GEO due to the recent activity from the CME arrival on 04 August. In the absence of any notable fast wind arrivals, the observed flux is expected to remain at or near current levels, perhaps rising to Moderate as the Van Allen Belts relax outward.

The associated 24-hour electron fluence is expected to remain below Active (1e8 integrated pfu), but perhaps with a slight rising trend, as indicated in MOSWOC REFM.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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